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A Wireless Testbed Development for a Telediagnosis and Telemammography Network - An Undergraduate Summer Training Program

1. Introduction

Providing mammographic services to women in underserved areas via telemammography is very important [1-3]. With remote computer-aided breast cancer detection and diagnosis, it has the advantage of higher penetration of women for cancer screening. This training program relates to research to develop a new telemammography scheme which is directed at the development, optimization, and evaluation of a new class of computer-assisted diagnostic system for telemammography applications. In the new telemammography scheme, we use Internet and wireless transmission medium to provide mammography to women in regions where physicians who specialize in diagnosing breast cancer are scarce.

Through this training program, the trainees learn the process of breast cancer diagnosis and the role of mammography; establish understanding of mammography; learn the basic principle of medical image processing; understand the role of wireless communications in telemammographic services; understand the architectures of wireless communications systems; understand the performance impact of wireless systems on telemammography [4]; and program and design elements for a wireless system/test bed.

2. Report Body

2.1 Test Bed and Telemammography Network Architecture

2.1.1 Test Bed and Network Architecture

A telehealth network architecture was first developed. As shown in Figure 1, in this proposed network architecture, there is a remote site and a central health office. A wireless transmission entity is in the center of the network. The Summer 2003 training program focuses on the development of a software package to provide teleconferencing capability between the remote site and the central office and the development of RF transceiver with a three band transmission capability (900 MHz, 2.4 GHz, and 5.7 GHz).

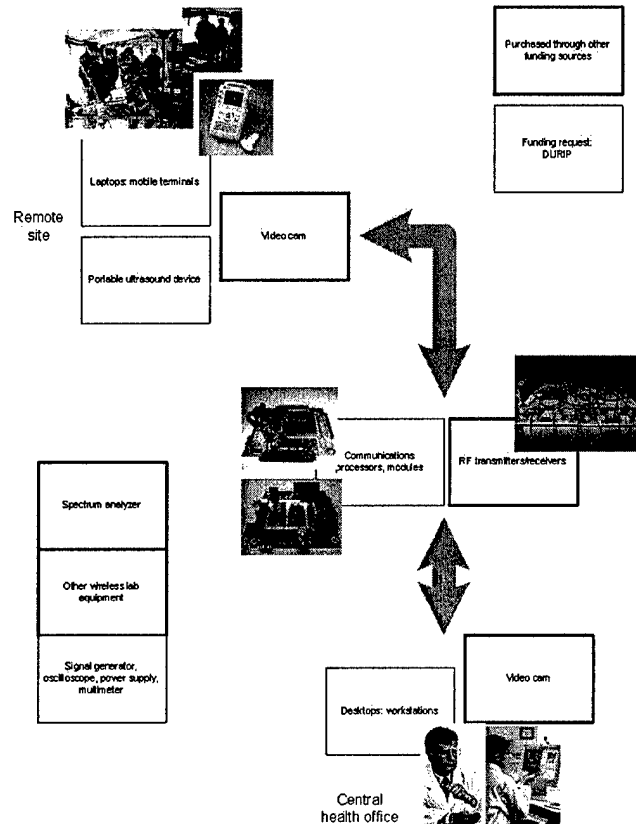


Figure 1: Telehealth network architecture.

2.1.2 Training Program Overview

In the summer of 2003, we ran our first training program under this award/funding support. We received approximately 20 applications and 9 students were selected to participate in the training program. There are 4 mentors (Profs. H. Man, U. Tureli, W. Qian, and Y. D. Yao). Additionally, there are two graduate students who interacted with and advised the undergraduate trainees. The undergraduates participated in 6 projects (see subsection 2.2.3).

2.2 Weekly Activities

2.2.1 Training Elements

This 12-week training program is organized and scheduled into 12 units. There are learning elements (Java programming and socket programming) and laboratory assignments (electronic components selection and testing) for each unit. There are presentations and seminars by mentors. Another important element is the weekly all-hands meeting.

2.2.2 Weekly Meetings

There are weekly all-hands meetings for trainees to report work progress and plans for the following week. Figures 2 through 5 are pictures from one of the weekly meetings. Mentors, graduate students and undergraduate trainees have extensive interactions through the weekly meetings. Students also gain experiences in presentations and professional communication.



Figure 2 A weekly all-hands meeting.

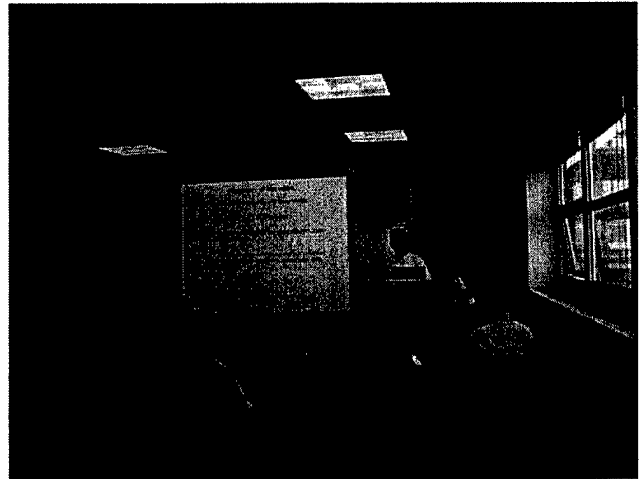


Figure 3 Student presentations, RF test bed.

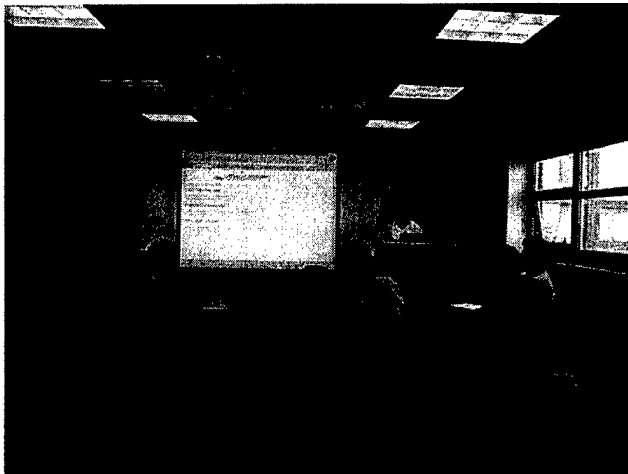


Figure 4 Student presentations, transmission block.

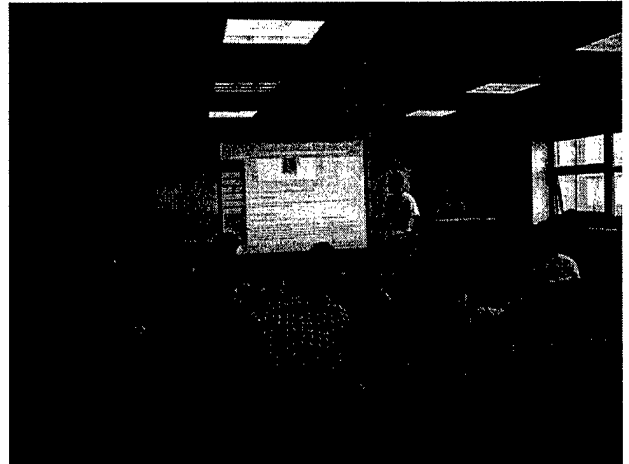


Figure 5 Student presentations, measure team.

2.2.3 Projects

The following lists 6 projects conducted in the summer program,

- (1) Development of an OpenH323 based software package to support teleconsultation (audio/video networking, graphic interference) in a telemammography network. Two students participated in this project. Prof. Han is the supervisor. In this project, trainees gain experiences in network architecture, multimedia networking, and socket programming.
- (2) Test bed control through handheld device and web interface. Two students are in this project. Prof. Tureli supervised this project. In this project, trainees gain experiences in wireless communications, wireless test bed, and software programming.
- (3) Mammogram database management and analysis. Two students worked with Prof. Qian in this project. In this project, students gain experiences in database management and mammogram processing.
- (4) Development of a tri-band RF front end for a wireless telemammography test bed. One trainee and another undergraduate from a separate research program worked on this project. Prof. Yao is the supervisor. In this project, trainees gain experiences in RF transmission requirements in telemammography networks and hardware development.
- (5) Wireless and test bed performance evaluation through interactive web interface (Java). One student participated in this project. Prof. Yao is the advisor. In this project, the student gains experiences in wireless networking and java programming.
- (6) Security in wireless handheld device for medical applications. One student participated in this project. Prof. Yao is the advisor. In this project, the student gains experiences in the security requirements in telemedicine and telemammography applications and security protocols.

2.3 STB: Stevens' Tri-Band RF Front End

One of the important accomplishments of the Summer 2003 training program is the successful development of a RF transmission front end with three operation bands, 900 MHz, 2.4 GHz, and 5.7 GHz. Figure 6 shows a block diagram of the STB, Stevens' Tri-Band RF front end. Figure 7 shows the developed board.

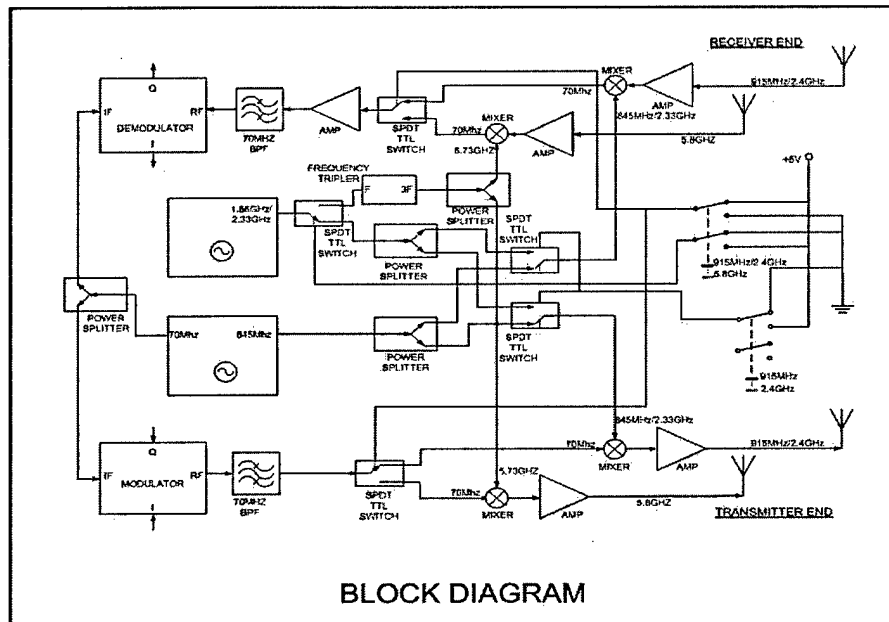


Figure 6 STB design block diagram.

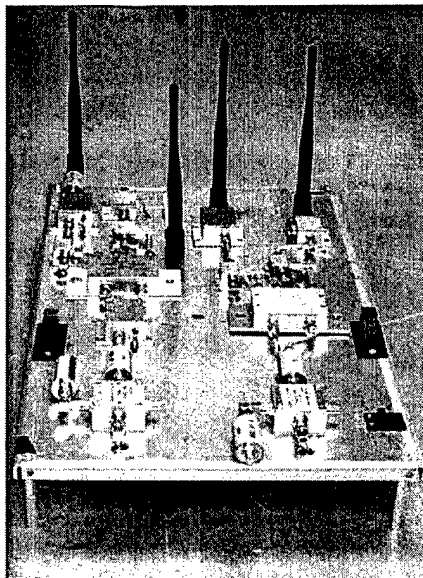


Figure 7 Completed STB board.

2.4 Seminar by Medical Imaging and Telemammography Expert

Dr. Wei Qian of Moffitt Cancer Center came to Stevens to advise this summer undergraduate training program. He gave a seminar (Figure 8) to present basic principles of medical imaging, including film-screen mammography and direct digital mammography.



Figure 8 Students listen to a presentation by Dr. Wei Qian of Moffitt Cancer Center.

2.5 Mentor Involvement

Faculty members (Dr. Yu-Dong Yao, Dr. Hong Man, Dr. Uf Tureli, and Dr. Wei Qian) interacted with students frequently. A number of graduate students worked with the undergraduates in a team and contributed significantly to the training program. Faculty mentors and undergraduate trainees attend weekly all-hands meetings. Such a group setting serves an important mentoring process. Additionally, faculty mentors visit the trainees in the research laboratory at least once a week. This gives an opportunity for individual mentorship.

3. Key Research Accomplishments

- A telehealth and tediagnosis network architecture (Figure 1) was developed, with applications to telemammography
- A software package based on OpenH323 was developed to support teleconference, with applications in a telemammography network
- A tri-band (900 MHz, 2.4 GHz, and 5.7 GHz) RF front end was developed (Figure 7)

4. Reportable Outcomes

- Developed an OpenH323 teleconferencing software package, which is intended for communications between remote sites and a central office in a telemammography network
- Developed a tri-band RF front end (STB: Stevens' Tri-Band) (Figure 7), which is a key component of a wireless test bed for the telemammography network

- Submitted a DURIP funding application, Wireless Testbed Development for Telehealth and Telediagnosis, to support a comprehensive test bed development

5. Conclusions

This training program has given undergraduate students good opportunities to understand the importance of mammography and tele mammography. It shows engineering students (electrical and computer engineering) the role of engineering and technology in health care and medical services. The training program also enables the undergraduate students interact with faculty and graduate students in learning and research. The Summer 2003 program also results in one developed software package and one hardware RF transceiver, both can be used in the tele mammography network test bed.

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